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ENERGY

No. 60

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PROBLEMS AND WAYS OF ENERGY DEVELOPMENT IN USSR DISCUSSED

Novosibirsk EKONOMIKA I ORGANIZATSIYA PROMYSHLENNOGO PROIZVODSTVA in Russian No 3, 1981 pp 16-45

[Article by A.A. Makarov, doctor of economic sciences and section chief, USSR Academy of Sciences Institute of High Temperatures, and L.A. Melent'yev, academician, Hero of Socialist Labor, deputy academic secretary, USSR Academy of Sciences Division of Physical and Technical Problems in Power Engineering, and department chief, USSR Academy of Sciences Institute of High Temperatures, Moscow: "Problems and Ways of Energy Development in the USSR"]

[Text]

> The party and government attach enormous importance to the progressive development of the fuel and energy complex. During the years of the 10th Five-Year Plan period the power-worker ratio in the country increased by a factor of 1.4. The economic strategy of the CPSU in this area for the 11th Five-Year Plan period consists in the efficient enlistment into the economic cycle of the fuel and energy resources of the eastern and northern regions of the country, improvement of the structure of the fuel and energy complex, further development of the unified energy system and a reduction in the specific consumption of fuel and the cost of electric and thermal power. The decisions of the 26th Party Congress called for improvement of the utilization of fuel and energy resources, a reduction in the consumption of oil and petroleum products as furnace fuel oil and a leading pace in the development of nuclear power. Plans have been made to increase the scale of the utilization of renewable energy sources in the national economy, such as water power, solar, wind and geothermal power. In the area of scientific research efforts will be concentrated on the development of nuclear and the creation of the fundamentals of thermonuclear power and on improvement of methods of converting and transmitting energy.

Main Stages in Development of Energy in the USSR

Three stages are rather distinctly discernible in the supplying of energy for our national economy.

The first began with the GOELRO [State Commission for the Electrification of Russia] plan and lasted to the end of the 50's. Its characteristic features were the following:

High rates of growth of the production and consumption of fuel and energy resources (with the almost total absence of their exportation and importation).

A drastic reordering of the structure of power consumption--an increase in the proportion of high-temperature and power processes at the expense of medium- and low-temperature processes (cf. fig 1).

A very slow growth (nearly stabilization), caused by this structural reordering, in the overall power net utilization factor.

The leading pace of the electrification of the national economy as compared with other kinds of power consumption and, corresponding to this, a rapid growth in labor productivity.

The dominant role of solid fuel--coal, peat, shale and firewood--in the production of primary energy resources (fig 2).

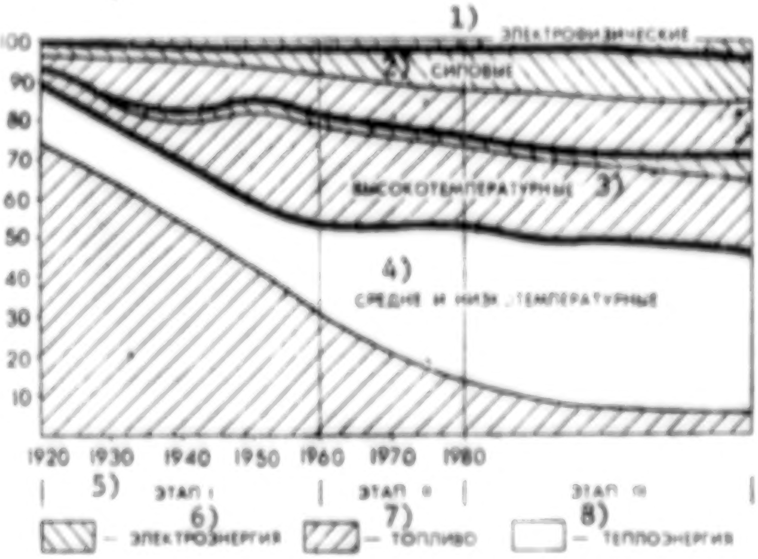

Figure 1. Change in Structure of Energy-Consuming Processes

Key:

1. Electrophysical
2. Power
3. High-temperature
4. Medium- and Low-temperature
5. Stage I
6. Electric power
7. Fuel
8. Thermal energy

All these features of the development of energy (except the last) were caused by industrialization of the national economy.

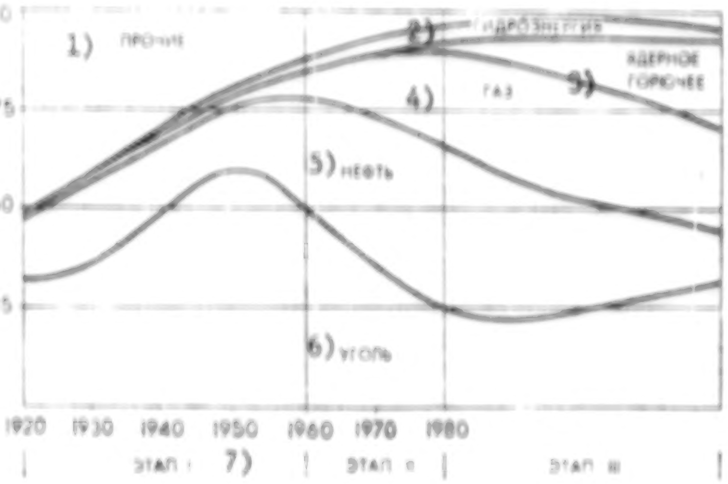

Figure 2. Change in Structure of Energy Sources

Key:

1. Other
2. Water power
3. Nuclear fuel
4. Gas
5. Oil
6. Coal
7. Stage I

The beginning of the second stage is associated with the new energy policy adopted at the 21st CPSU Congress--with the drastic increase in the proportion of oil and natural gas in the country's fuel and energy balance. The 37- to 68-percent increase in the proportion of these kinds of fuel of the total output of energy resources achieved during the 20-year period from 1960 through 1980 is regarded rightfully by many as a real scientific and technical revolution in our energy industry. Its effectiveness can be illustrated with the gas industry as an example. The creation of this new industry required in 1960 to 1975 23 billion rubles of direct capital investment and about 6 billion rubles of capital investment in allied industries of the national economy. The net savings gained during the same period equaled 60 billion rubles with the release (according to 1975 data) of 800,000 skilled personnel. Even more effective during this period were two programs for development of the oil industry--mastery of the Ural-Volga and West Siberian oil-bearing provinces, each of which in terms of a fuel equivalent is equivalent to the program for creation of the gas industry. On the whole doubling of the percentage of oil and gas in the country's balance produced a net savings of not less than 200 billion rubles, which equaled during this period on average half of the five-year-plan capital investment in material production.

However, the radical reordering of the structure of the production (output) of primary energy resources with all its importance by no means exhausts the characteristics of the second stage of development of the USSR's energy industry. The completion basically by the end of the 50's of the period of industrialization of the national economy was reflected considerably in the nature of the subsequent changes in the structure of power consumption. Rapid reordering was replaced by a relatively slow evolution of the structure of power-consuming processes: practically complete stabilization of the percentage of medium- and low-temperature processes with a slow growth in the percentage of power-consuming on account of a reduction in high-temperature (cf. fig 1). The pace and direction of these structural changes is approximately the same as in other industrially developed countries.

Characteristic of the second stage of energy development is also the completion for the most part of the electrification of stationary power-consuming processes (mechanization of the still remaining manual labor required a quite small consumption of electric power--about 50 billion kWh--and was restrained for other reasons), along with the introduction of electric power into high-temperature and other technological processes, as well as in mobile power processes (primarily in railway transportation). However, at this stage inexpensive high-quality kinds of fuel competed actively with electric power--natural gas in technology and liquid fuel in transportation, construction and agriculture. As a result was observed a slowing of the pace of electrification of the national economy and to a still greater extent slowing of its positive influence on a growth in labor productivity.

The slight variability of the structure of residual power consumption with a continuing growth in the efficiency of key power-producing and power-consuming processes (to which was conducive, in particular, an increase in the percentage of high-quality fuel) caused a rapid growth in the overall power net utilization factor--from 34 percent in 1960 to 47 percent in 1980. As a result of this rates of growth of the consumption of energy resources were reduced; some reduction in rates of economic growth was also felt. The rate of growth of the production of energy resources was higher than of consumption because of a rapid increase at this stage in the exportation of energy resources. Now it has reached 15 percent of internal consumption, which no other industrially developed country can allow itself.

As the result of these transformations, a large and highly efficient fuel and energy complex (TEK) has been created in the USSR. Providing almost one fifth of the world production of energy resources, it has come close in terms of this indicator to the USA's energy industry, considerably outdistancing it in absolute growth achieved (cf. table 1). In recent years the USSR, maintaining its leadership in the production of coal, has reached first place in the production of oil, is rapidly approaching first place in the production of gas, is holding it firmly with regard to the centralized production of thermal energy (central heating), and holds second place in the production of electric power. During the last 20 years 80 percent of the growth in the production of energy resources was gained in the USSR on account of oil and gas (cf. table 1). But, unlike capitalist countries, the orientation toward high-quality fuel did not disturb a further increase in the production of coal, especially by the method of strip mining in eastern regions of the country.

Table 1. Dynamics of the Production Structure of the Fuel and Energy Complex*

Component	1960 Million tons of conventional fuel (t.c.f.)	%	1965 Million t.c.f.	%	1970 Million t.c.f.	%	1975 Million t.c.f.	%	1980 Million t.c.f.	%	Inc. 1961-1975 mill. t.c.f.	%	Inc. 1976-1980 mill. t.c.f.	%
Production of energy resources in USSR (estimate)	743	100	1030	100	1325	100	1650	100	2025	100	907	100	375	100
Of these: oil and condensate	211	29	346	34	503	38	702	43	867	43	491	54	165	44
gas	54	8	150	15	234	18	338	21	508	25	284	37	170	45
Total:	265	37	496	49	737	56	1040	64	1375	68	775	85	335	89
Coal	373	50	413	40	433	33	465	28	489	24	92	10	24	6
Water power	18	2	29	3	42	3	43	3	59	3	25	3	16	4
Export of fuel from USSR	60	8	117	11	167	13	242	15	345	17	182	20	103	27
Including: oil and petroleum products	47	6	95	9	141	11	185	11	No info.		138	15	No info.	
World production of energy resources	4650		5790		7510		9060		11,000		4400		1940	
USSR's percentage		16		18		18		18		18		21		19
Production of energy resources in USA	1477		1760		2205		2120		2200		640		80	
USSR percentage vs. USA		50		59		60		77		92		142		470

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*Recalculation for conventional fuel was done in terms of the mean level of the actual consumption of fuel for one generated kWh of electric power.

But unfavorable trends began to be evidenced ever more distinctly in the fairly successful development of the TEK since the middle of the 70's. An analysis has shown that the majority of them were caused by objective reasons, but some are also of a subjective nature. The new objective factors which have come into influence are of such great importance that it is necessary to speak of a serious change in conditions for development of the USSR's energy industry, i.e., of completion of the second and transition to the third stage.

The following are the most important of these factors.

The appearance of a fundamentally new energy resource--nuclear energy--and the ability to use it on a rapidly growing scale for the purpose of producing electric power, steam and hot water in large central heating plants.

The slowing for a number of reasons (including economic) of the rate of growth of the production of high-quality fuel, especially of oil, and therefore a gradual reduction in its share in the fuel and energy balance of the country. It is not possible to compensate this reduction only by means of nuclear power. More rapid development of the coal industry is necessary (principally of strip mining in the eastern regions of the country), including by the end of the century the production of synthetic liquid fuel.

A considerable rise in the price of organic fuel on account of the relative exhaustion of the largest and most favorably situated oil deposits, and later of gas, too. A distinctive feature of the previous stage in energy development consisted in the utilization of chiefly precisely these deposits: The Ural-Volga and West Siberian oil-bearing provinces yielded 70 percent of the oil produced in the country; the three largest gas-bearing regions provided 70 to 75 percent of the entire production of gas. And under the new conditions it is difficult to provide for the increased production of these kinds of fuel in the country by means of a limited number of sources. Besides, according to conceptions of geologists, large deposits are discovered first but with an increase in the extent of exploration of the territory their share in new discoveries rapidly diminishes. An ever greater percentage of capacities put into service (especially in the oil industry) is directed not toward an increase in production but toward compensating the departure of existing capacities, and under worse geological conditions. In combination with the placing of key sources of fuel (especially of gas) at great distances from consumption centers, this results in an almost threefold increase in national economic expenditures per unit of an increase in demand for organic fuel, and this indicator is substantially higher for oil.

An increase in the capital intensiveness of the production of energy. Under the conditions of the rapid rise in price of organic fuel there has been an increase in the effectiveness of using for the production of electric and thermal energy nuclear power plants (condensation and heat-and-electric generating plants), hydroelectric power plants, including pumped storage power plants, nuclear power plants for supplying heat, and the like. All these advanced facilities, making possible a considerable savings of fuel, require two- to threefold larger capital investment per unit than steam turbine power plants and boiler plants to whose share fell hitherto the main production of electric power and heat.

The complication of ecological restrictions and an increase in the requirements for protection facilities and, consequently, an increase in their cost.

These big changes in the development of the TEK have required the development of a new energy policy. Its key tenets were determined by the decisions of the 25th CPSU Congress, in which emphasis was placed on saving fuel and energy and on the speedier development of nuclear power, the coal industry and water power with the careful use of fundamentally limited oil and gas resources. The new policy should find concrete quantitative embodiment in the program for development of the USSR's energy industry for the long term, which is being developed at the present time as a State program of the highest importance.

Radical changes in conditions for the development of the energy industry must have a strong influence on the rate of growth and structure both of the consumption and production of energy resources, as well as to a definite extent on the development of the national economy as a whole. The distinctive features of the forthcoming third stage in the development of the USSR's energy industry are analyzed in these aspects below.

Key Trends in Alteration of Energy Consumption

For the purpose of estimating the extent and structure of energy consumption it is necessary to recognize and trace a combination of objective trends characterizing the proportionality in the development of the energy industry and of the USSR's national economy. The original trends here are those of modifying the consumption of residual energy which is used directly in consumer plants and is actually necessary with the present means and organization of production--with motors and machinery, processing plants, building structures and materials used and the like. The amount of residual energy is compared via the efficiency of power-consuming units with the electric power, steam and hot water and fuel supplied to these units. The ratio of the consumption of residual energy to the consumption of energy resources characterizes the level of power engineering perfection.

An analysis has shown that the specific energy intensiveness of the national income in terms of residual energy (gross, i.e., without taking into account its use for the internal needs of the energy industry) remained practically unchanged during the last 20 years--from 12.2 to 12.4 Gcal per 1000 rubles. This stability was formed as the resultant force of an increase in the energy intensiveness of transportation and agriculture with its reduction in public utilities and domestic use and invariability of the energy intensiveness of industry.* The latter, in turn, was the result of two opposing trends--of a reduction in the specific power intensiveness of the majority of branches of industry on account of technical progress and of an increase of the share of the most energy intensive industries (chemistry, machine building, etc.) in total product output.

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*The energy intensiveness of agriculture and especially of industry in this case is computed in terms of net and not of gross output.

The balancing of warring trends, resulting in stable energy intensiveness of the national income in terms of residual energy, took place during this period not only in the USSR but also in the USA, i.e., in both industrially developed countries having a complete and basically self-providing cycle of material production. This apparently makes it possible to consider stability of the energy intensiveness of the national economy in terms of residual energy an objective characteristic of the forces of production in the last 20 years--the era of relatively inexpensive energy.

The increase taking place in the capital intensiveness of the energy industry and the rise in the cost of organic fuel will probably result in a reduction in the specific energy intensiveness of the national economy in terms of residual energy. This can be expected to the greatest extent in industry (where energy saving technologies will gain priority) and in public utilities and domestic use, chiefly on account of saving heat for heating. But both in agriculture and in transportation an increase in energy intensiveness can be slowed considerably on account of gradual saturation with equipment, the improvement of agricultural technologies and the improvement of the transportation system, the quality of roads, transport vehicles, etc.

On the other hand the analysis has shown that a relative reduction in residual energy intensiveness is a very slow process and one resistant to change. It requires the implementation of a great number of on the whole relatively small and dispersed measures. In addition to the re-evaluation of existing and new technologies is required the correction of many State standards and established approaches and, finally, the psychology of energy consumers. During the first 10 years of carrying out these measures it will obviously be possible to reduce the specific consumption of residual energy by not more than 5 to 7 percent and in the next decade by 15 to 20 percent as opposed to the current level. But in absolute dimensions this will be a savings measured in dozens and hundreds of millions of tons of conventional fuel per year.

It is as yet difficult to predict with great certainty on account of what types of energy-consuming processes the greatest savings of residual energy will be achieved. There are great opportunities for this in medium- and low-temperature processes (better organization of technological processes, improvement of the insulation of buildings, ventilating systems, etc.) and in mobile power-consuming processes--improvement of the structure of transportation and efficiency of its speed, improvement of the road network and transportation vehicles and of the organization of construction and agricultural production and the like. There is considerable potential also in high-temperature processes (melting, heating and annealing materials), but its implementation in the majority of cases involves the introduction of new technologies and a reduction of the materials intensiveness of production. The enactment of these savings opportunities in conjunction with continuing changes in the structure of production will obviously be conducive to a progressive increase in the share of power processes in the total consumption of residual energy, a further reduction in the share of high-temperature processes and a changeover to a reduction in the share of medium- and low-temperature processes (cf. fig 1).

These dynamics will to a considerable extent determine the requirements for the structure of converted forms of energy. A direct consequence of this is, in particular, an extension of the areas of application of electric power and a further reduction of the sphere of the direct utilization of fuel.

Under the new conditions the use of electric power will become a major means of improving energy consumption. Along with the increase mentioned in the share of traditional methods of using electric power, its ability to compete with liquid fuel and natural gas (the cost of which has been increasing repeatedly) has been increased substantially in a number of fields. In stationary processes an electric drive for gas line compressors instead of a gas-turbine, which consumes almost one tenth of the gas produced in the country, will become more efficient. In mobile power engineering the electrification not only of the greater part of railway transportation, but also of other route transportation such as urban and intraplant transportation, strip mine transportation, etc., is economically justified. The opportunities for electrifying agricultural power processes (including field working) and construction operations are great. As a result the percentage of electric power in mobile power engineering can be increased from 7 percent at the present time to 13 to 15 percent at the end of the century and from one fourth to one third in the following 15 to 20 years.

A similar process can be predicted with even greater certainty in high-temperature and other technological processes. The direct reduction of iron, electric melting, induction heating, electrospark and other methods of machining metal represent a far from complete list of the technologies whose economic efficiency will increase greatly under the new conditions. As a result the percentage of electric power in high-temperature processes should approximately double by the end of the century.

In medium- and low-temperature processes the use of electric power will be justified in those cases when the careful enactment of temperature conditions or the regulation of thermal processes are required, such as especially precise thermal processes, the heating of cattle production areas for raising young stock, air-conditioning in precision machine building, in processes for drying fabric and fruit and many others. In southern regions of the country thermocompressors which convert electric power into cold in the summer and heat in the winter will obviously become widespread. And although even no more than 5 percent of medium- and low-temperature processes are provided with electric power at the end of the century, this consumes a great amount of electric power and will make it possible to improve the quality of heating.

The combination of the possible new areas of application of electric power is so large that it is possible to assume with justification a 40- to 45-percent combined increase in its consumption in the 80's and an almost 60-percent increase in the 90's. By opening up additional opportunities for the enlistment of nuclear fuel and coal in power engineering, the process of hastening electrification of the nation's economy will make it possible to free annually a great amount of liquid fuel and natural gas. As a result the percentage of electric power of residual (useful) power consumption can double by the end of the century as compared with the present.

The hastened electrification of the national economy in combination with centralization of the production of heat energy on the basis of power-and-heat generation (the combined production of electric power and heat) will make it possible in the forthcoming period to hasten even more the process of displacing the direct use of heat in consumer plants. As early as in the forthcoming five-year plan period and further to the end of the century it is possible in principle to stabilize the absolute growth in the direct consumption of all kinds of fuel and to reduce it twofold in the following period. The reduction in the percentage of the direct consumption of fuel in the production of residual energy corresponding to this is shown in fig 1.

In addition to changing the specific consumption and the structure of the consumption of residual energy, as well as its provision with the major kinds of energy carriers, worsening of the conditions for the development of the energy industry should stimulate the improvement of the entire equipment for converting and distributing energy. Unfortunately, in recent years this process has been retarded. For example, in the Seventh Five-Year Plan period on account of improvement of the efficiency of the conversion and distribution of energy a yearly savings of almost 150 million tons of conventional fuel (in terms of the 1965 level) was achieved, and in the 10th Five-Year Plan period with an almost twofold increased amount of consumption the savings will equal only slightly more than 100 million tons of conventional fuel (in terms of the 1980 level). This is explained by the exhaustion of a potential for improving efficiency such as the reconstruction of the locomotive fleet of railroads, improving steam parameters and the unit power of thermal electric power plant units, an increase in the percentage of gas and liquid fuel in all types of power plants, etc. Under the new conditions it is vitally necessary to put new potential for saving into effect, such as centralization of the heat supply, the removal of obsolete equipment from use, dieselization of the motor vehicle fleet, the utilization of secondary energy resources, new methods of producing electric power, etc. Estimates have demonstrated the possibility of reducing by approximately 20 percent the increase in the utilization of energy resources on account of further improvement of the equipment for converting energy, i.e., an increase in the total efficiency of energy resources.

An important potential for an increase in national economic efficiency lies in the organization of the energy industry, especially of the energy facilities of consumers, which is well illustrated in the example of heating facilities.

TETs's and large boiler houses now supply with steam and hot water almost half of these demands of the national economy. The remaining heat is produced by about 250,000 small and very small boiler houses which annually burn 50 million tons of conventional fuel. Employed in their operation are 3.5 million people--1.5-fold more than in the production, refining and transporting of fuel and in the centralized production of electric and thermal power. In recent years in the country 150,000 very small boilers have been produced annually, whose installation requires 2.5 billion rubles of capital investment (40 percent of the annual capital investment in energy), and whose maintenance requires an additional 120,000 people. Plainly, the hastened centralization of the supply of heat (which is now being prevented by departmental barriers) would produce a large savings of both capital investment and of fuel and especially of labor costs.

There is also a great potential in other areas of the energy facilities of consumers. For example, an analysis of the operation of 150 enterprises of various branches of heavy industry showed that the wear of equipment in the energy facilities of these enterprises is twofold greater and the capital-labor ratio lower than in main shops. The situation is even worse in other sectors of industry and the national economy. Elimination of this situation requires radical modification of the system of planning, controlling and monitoring energy consumption.

Summing up, it must be stated that a fairly rapid (although with a diminishing rate of growth) quantitative growth in energy consumption and rapid qualitative improvement of its structure will be maintained in our country in the foreseeable future. The entire combination of measures for saving energy can balance the substantial growth (by 30 to 40 percent) in the consumption of energy. Stabilization and possibly even some reduction in the absolute growth in the demand for energy resources are thereby probable by the end of the century. However, the relative extent of energy saving in the USSR will apparently be lower than has been observed in other most highly advanced countries. This is explained firstly by the advisability of further electrification and motorization of the national economy, i.e., by leading growth in energy with the highest potential, the production of which inevitably is accompanied by very great losses. Secondly, the leading growth in the most energy intensive branches of industry--nonferrous metallurgy (especially aluminum), chemistry (plastics and fibers), machine building, etc.--must be maintained in the structure of national economic production for a long time yet.

Key Trends in the Production of Energy Resources

The fuel and energy complex (TEK), as one of the areas of the national economy most heavily supplied with equipment, displays great sluggishness in development. The standard time required for the construction of many TEK projects equals 6 to 8 years, planning and coordination take 3 to 5 years and the preparation of allied industries up to 5 or 6 years. As a result the required lead time for large structural changes in the development of the TEK is two or three five-year plan periods. Therefore, the comprehension of the new conditions for development of the TEK which had been arrived at at the beginning of the 70's will produce real changes in its production structure only by the middle of the 80's. Meanwhile it is necessary to encounter the negative phenomena of sluggishness, when decisions made earlier come in contradiction with the new conditions for development. In the current five-year plan period, as pointed out by the November 1979 Plenum of the CPSU Central Committee, this was expressed in a lag in the development of the coal industry, a slowing with regard to the planned rate of growth in oil production, a reduction as compared with the preceding five-year plan period in the absolute growth of the production of electric power, etc. Meanwhile the gas industry, the boosting of which had been persistently prepared in previous periods, for the first time in its history not only fulfilled but even overfulfilled the guide figures for the five-year plan. As a result, as is obvious from table 1, in the 10th Five-Year Plan period the percentage of high-quality kinds of fuel in the balance continued to increase, although at a twofold slower rate than in the preceding period. Eighty-nine percent of the growth in the production of energy resources was gained on account of oil and gas, and coal provided only 6 percent, so that its percentage of the total output was reduced to 24 percent.

The dynamics of the forthcoming reordering of the structure of energy resources to be produced at the new third stage, found by taking into account the sluggishness of the TEK, are illustrated in fig 2.

The most critical problem of the forthcoming stage in the development of the TEK will be satisfaction of the demand of our own country and of CEMA member countries for liquid fuel and chemical raw material. This requires a definite sequence of fairly urgent and large-scale measures. In the first 10 to 15 years, in addition to the dieselization of the motor vehicle fleet mentioned, it is necessary to reduce drastically the use of fuel oil at electric power plants and in boiler houses (it hitherto has continued to grow) and to ensure a rapid increase in the thoroughness of oil refining, which requires the deployment of large-scale production of the appropriate equipment. In the following period emphasis must be placed on the electrification of mobile power processes and on the production of synthetic motor fuel from coal and shale, which is the general trend for the long term. And finally it is necessary steadily to pay very great attention to improving the equipment and technology for oil exploration and production, in particular to increasing the extraction of oil from strata.

The heavy displacement of liquid fuel from electric power plants and boiler houses requires compensating it by means of other energy resources. At existing plants this can be done practically only by means of natural gas. A rapid absolute and relative increase in the production of natural gas is required in connection with this, as well as for satisfying the increase in the demand for high-quality fuel (technological needs, heat supply plants in cities and the like) and export needs up to the end of the century. Together with the mastery of ever new deposits of it (chiefly in the north in Tyumenskaya Oblast) and the further development and improvement of the country's unified gas supply system, this requires considerable effort with regard to the creation of gas storage tanks for regulating the irregularity of fuel consumption which up to now has chiefly been provided for by means of fuel oil. By the end of the 20th century a basis can appear for further stabilization of the production and consumption of natural gas in the country, caused by electrification of the national economy and the extensive utilization of nuclear power. But this will not imply a reduction of effort with regard to development of the gas industry, since at that period it will be necessary to compensate the reduction in the production of gas at the most effective deposits in Tyumenskaya Oblast and to do this, to all appearances, on account of the mastery of less large and more remote deposits.

The trends in the development of the oil and gas industry discussed, as is obvious from fig 2, entail in the next decade a further increase in the percentage of hydrocarbon fuel in the country's balance, and in the next . reduction of it. It is important to stress that this will be due not to the depletion of natural resources (substantially less than half of the predicted reserves of hydrocarbons will be used up in the country in 40 years even with the same policy), but to the intelligent utilization of the resources which the national economy can assign for the development of the energy industry.

Nuclear power will grow most rapidly in the forthcoming period. Its percentage of the total output of energy resources by the end of the century will reach 10 to 12 percent and will double in the next 15 to 20 years--upon condition of the mass use of nuclear power not only for producing electric power but also for the centralized production of steam and hot water (nuclear TETs's and boiler houses). Here nuclear fuel produces the greatest national economic savings since it replaces very expensive fuel (gas and fuel oil).

It can be expected that by the end of the century the problem of the mass production of bred nuclear fuel will be solved. With the rate of development of nuclear power seen now this will make possible the extensive utilization of reactors using fast neutrons and later, probably, of hybrid thermonuclear reactors, too. Obviously this solution requires the creation of remote nuclear power centers for breeding and separating plutonium with the transmission of electric power to consumers through a direct-current electrotransmission line.

The percentage of coal, of the total production of energy resources, will be reduced in the next decade and then, apparently, will stabilize at a level of 22 to 23 percent right up to the end of the 20th century. A further growth in the production of coal in eastern regions of the country (chiefly strip mines) is almost evident in the following period. A growing demand for eastern fuel will be created by the mass production of synthetic motor fuel, power engineering conversion (with the production of smokeless domestic fuel) and the production of electric power for transmission to European regions and the Urals through direct-current electrotransmission lines, which under certain conditions will prove to be more effective than the additional use of nuclear power.

Territorial relationships of the TEK will be characterized in the forthcoming period by a rapid increase in the flow of all kinds of fuel from eastern regions of the country, chiefly from Siberia. The extent of this flow will be such that from the middle of the 80's and right up to the end of the century it will provide for half of the demand of the European sector of the country even with the accelerated development of nuclear power there. However, by the end of the century the absolute increase in the flow of organic fuel from eastern regions will slow down considerably.

It is important to emphasize that the ways discussed for developing the TEK cannot be accomplished without serious scientific and technical progress. Measures such as the development of nuclear power, intensification of the extraction of oil from strata, new kinds of transportation for gas and coal and for the transmission of electric power from eastern regions, the conversion of coal into motor fuel, etc., will evidently be able to provide by the year 2000 only one half of the required growth in the production of energy resources. At the same time scientific and technical progress will be conducive to reducing the demand of the TEK for capital investment and material resources.

Influence of the Fuel and Energy Complex (TEK) on Development of the National Economy

At the new stage of development the USSR's energy industry, as will that of other industrially developed countries, will exert a considerable influence on development of the economy. On the macroeconomic level it is necessary to take into account the drastically increasing capital intensiveness of the energy industry. In connection with this it is necessary to conduct an active energy saving policy. For example, just a 1-percent annual reduction in the specific consumption of fuel and energy in the production sphere, as compared with their present dynamics, will make it possible to compensate by half the increase in the specific capital intensiveness of the TEK.

The new conditions for development of the TEK are exerting a strong influence on the majority of relatively particular energy economics solutions. Serving as the means of this influence are, for example, the closing costs for fuel and electric power arrived at in optimizing the longterm development of the energy industry.*

In the future development of the energy industry the system of forming closing costs will change considerably. Whereas at the preceding stage the country's closing fuel was the coal of the largest basins--the Donetsk and Kuznetsk--then under the new conditions these functions will begin to be performed by nuclear condensation electric power plants (AKES's). Under the conditions when the Donetsk Basin actually arrives at its greatest production capabilities and the enlistment of the coal of the eastern regions for the European sector (where three quarters of the demand for fuel is concentrated) is also limited, AKES's will become the key energy source, able to compensate a possible increase in demand or a reduction in the production of remaining energy resources.

Without discussing here the energy lines of reasoning for forming closing costs by kinds of fuel and by territory, let us mention the following distinctive features of them at the forthcoming stage.

The level of closing costs for coal, gas and fuel oil in almost all regions of the country will increase 1.5-fold and more as compared with their values at the beginning of the 70's. Furthermore, there will be a noticeable increase in the difference of these costs for coal on the one hand and gas and fuel oil on the other, which testifies to the advisability of refraining from supplying with high-quality fuel large electric power plants, industrial boiler houses of large enterprises, cement kilns and other consumers in which the utilization of gas and liquid fuel is relatively less efficient.

Closing costs for fuel will increase considerably more than closing costs for electric power, which should provide an economic incentive for hastened electrification of the national economy, especially in Siberia.

The new values of closing costs for fuel in the majority of regions will be substantially higher (e.g., more than threefold for oil) than the current prices for fuel, which poses the question of correcting these prices.

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*By closing costs is meant a system of interrelated specific economic indicators characterizing adjusted costs for the entire national economy for providing for the additional demand for various kinds of fuel and energy for the country's territory at specific periods of time. Cf. Andreyev, B.P. et al. "Basic Rules for Determining Closing Costs for Fuel," TEPLOENERGETIKA, No 8, 1967.

Utilization of the new values of closing costs for fuel and energy in mass technical and economic calculations will be an effective key factor in conducting a strict energy saving policy.

On the whole the analysis made of longterm trends in the development of the power industry testifies to the existence of real opportunities for satisfying the country's energy requirements on the basis of our own resources without considerably retarding the pace of economic growth. The problem consists in the detailed working out of specific ways of realizing these opportunities.

Guidelines for Improving Control of the Energy Industry

At the end of the 60's and beginning of the 70's the technological and territorial coherence of the energy industry had increased to such an extent that it was converted into a unified fuel and energy complex, or into the country's overall energy system. The country's unified oil supply and gas supply systems, as well as the unified electric power system, were basically formed at the same time.

However, the fuel and energy complex which actually exists has still not received an organizational form. As the result, the role of departmental interests in planning and controlling the energy industry is still great and the goals of the most total and high-quality satisfaction of the demand of the national economy for fuel at minimum public cost have been insufficiently realized. The negative consequences of this are only intensified with time--especially under conditions of the restructuring of the TEK which has begun.

For the purpose of changing the situation which has been created it is necessary to arrange for the thorough planning and control of the TEK with the performance of the following new functions:

The planning and supervision of specific measures for improving the energy facilities of consumers with the drawing up of individual item lists and with their total financing.

The planning and control of heating facilities for the purpose of increasing the degree of centralization and the technical level of supplying heat to consumers.

The development of comprehensive plans for development of fuel and energy industries and of plans for capital investment with their distribution among the components of the TEK and for purposes of improving energy consumption.

Comprehensive planning of the development of the TEK in a territorial section with the optimization of interregional links with regard to fuel and electric power.

The development of comprehensive plans for supplying fuel at the level not only of the country but also of regions with the creation of a system of on-line supervisory control of fuel and energy consumption.

The system of planning and controlling scientific and technical progress in the energy industry requires further improvement. The target program approach has opened up new opportunities here. However, for the purpose of its implementation is required a clear procedure for developing and coordinating with those who will carry it out a structure for target programs for scientific and technical progress with the creation of individual interdepartmental centers for controlling development and for supervision.

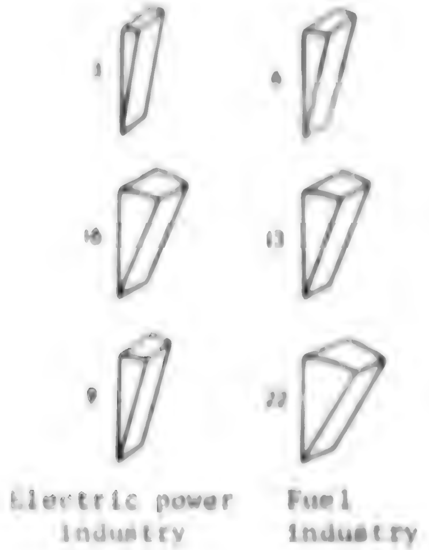
Special problems are involved in developing a program for the development of the energy industry for the long term and in choosing a substantiated technical strategy, which is of great importance by virtue of the great and steadily increasing sluggishness of the energy industry. New guidelines for technical policy in the energy industry must be developed for a future period of 15 to 20 years and more. This requires the periodic development and detailed thorough discussion of general longterm trends in the development of key TEK systems at an interdepartmental agency.

Solution of problems relating to comprehensive planning of the energy industry increases the amount of planning work by a large factor (as compared with the present). Therefore, the performance of the new functions is practically impossible without the extensive automation of the entire process of planning and controlling the TEK.

Another necessary prerequisite for improving the fuel and energy complex is the setting up of proper systems of technical accounting and of supervising the production and consumption of energy resources. Unfortunately approximately one quarter of energy facilities are not supplied with measuring equipment for keeping an objective record of the production and consumption of fuel and energy; the situation is especially bad in this regard in the area of supplying heat. The organization of supervision over fuel and energy consumption and the condition of energy equipment has also been carried out inadequately, which has had a negative affect on the efficiency of the fuel and energy complex.

Measures for further improvement of the system of economic control in the energy industry are necessary.

The actuation of a system of control and supervision in the energy industry in conformity with the requirements of the new stage of its development is a necessary condition and an important potential for improving the efficiency of the TEK and for solving the problem of reliable and high-quality satisfaction of the society's energy requirements.



As a percentage:

Of the total amount of industrial output (in wholesale prices of enterprises as of 1 Jan 1975)

Of cost of industrial production resources

Of total capital investment in industry

Figure 3. Share of the USSR Electric Power Industry and Fuel Industry in 1979

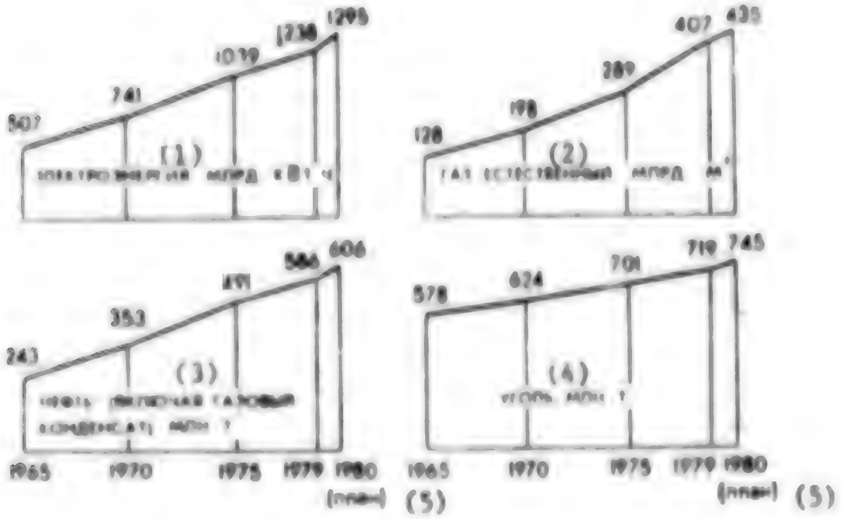


Figure 4. Production of Electric Power, Oil, Gas and Coal

Key:
1. Electric power, billion kWh
2. Natural gas, billion m^3
3. Oil (including gas condensate), million tons
4. Coal, million tons
5. Plan

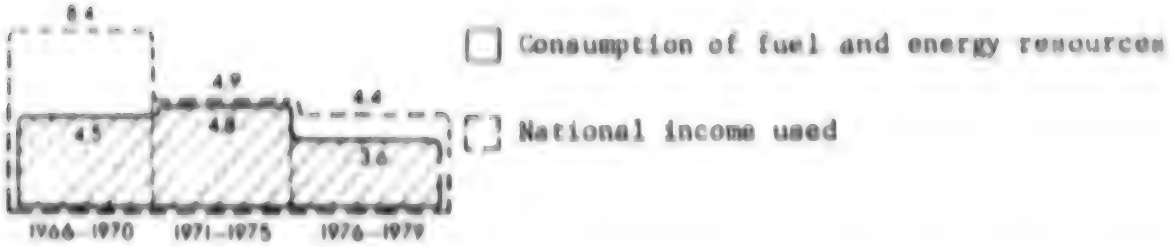


Figure 5. Mean Annual Rates of Growth of Consumption of Fuel and Energy Resources and of National Income Used for Consumption and Storage, % (Consumption of fuel and energy resources taking into account foreign trade balance and remainder at beginning and end of year)

ENERGY INTENSIVENESS OF THE NATIONAL ECONOMY

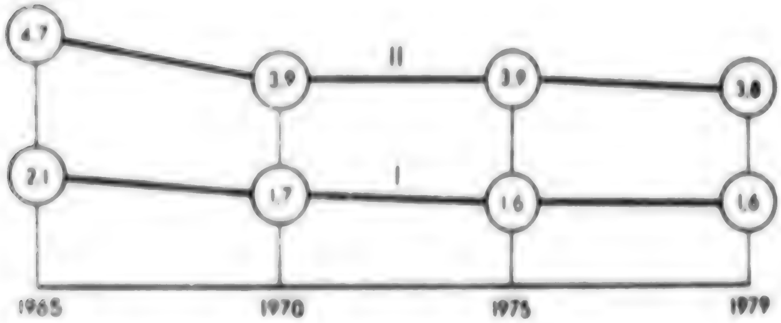


Figure 6. Kilograms of Conventional Fuel per Ruble
I--of gross national product; II--of national income used for consumption and storage

Table 2. Kilograms of Conventional Fuel per Ruble of Net Product of Sector

Sector	1965	1970	1975	1980 (estimate)
Industry	3.55	3.03	2.98	2.73
Agriculture	0.30	0.21	0.22	0.32
Transportation and communications	0.45	0.51	0.47	0.48

Energy intensiveness was determined in terms of the consumption of fuel and energy resources for production and non-production needs taking into account the foreign trade balance and remainder at the beginning and end of the year.

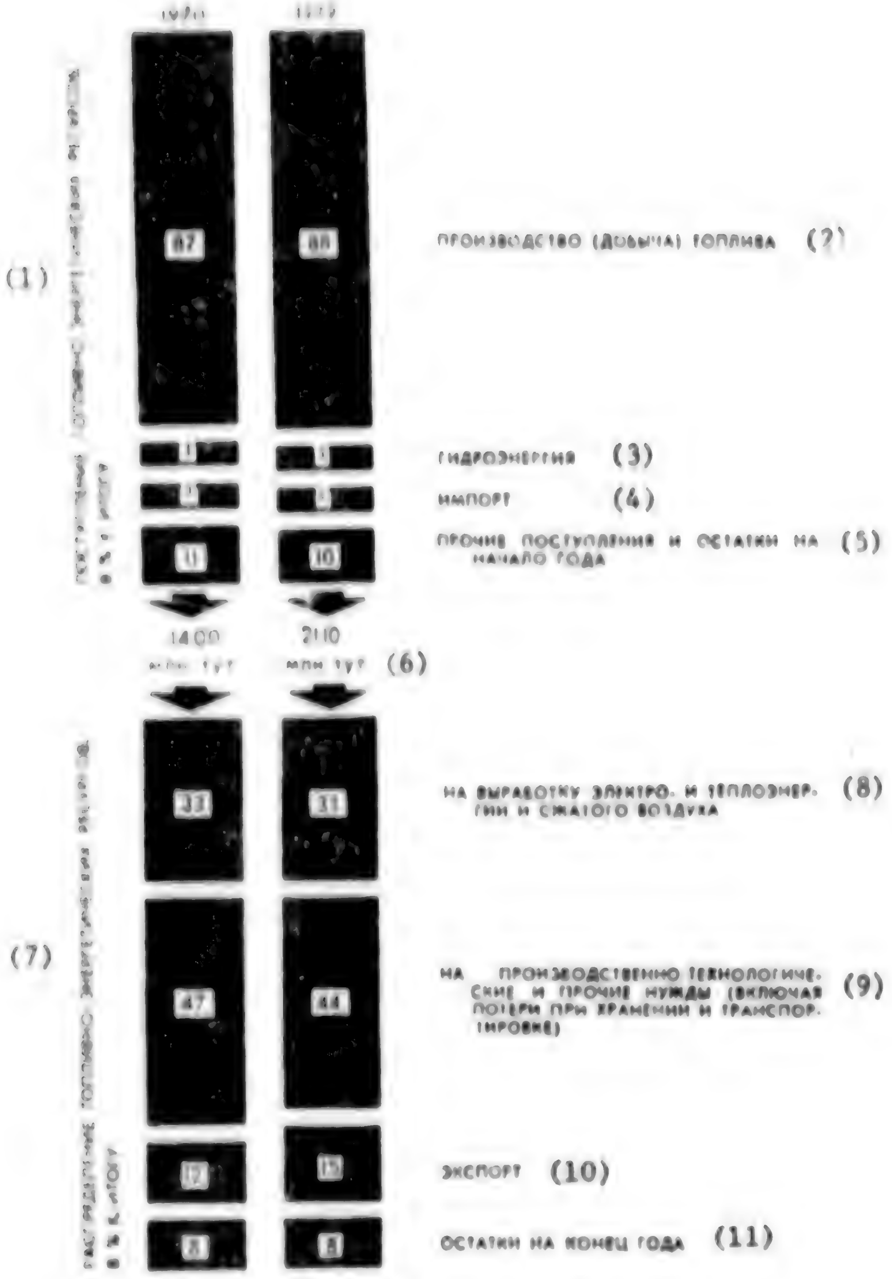


Figure 7. Fuel and Energy Balance

Key:

1. Input of fuel and energy resources as percentage of total
2. Production (output) of fuel
3. Water power
4. Imports
5. Other input and remainder at beginning of year
6. Million tons of conventional fuel
7. Distribution of fuel and energy resources as percentage of total
8. For production of electric and thermal energy and compressed air
9. For production technology and other needs (including losses in storage and transportation)
10. Exports
11. Remainder at end of year

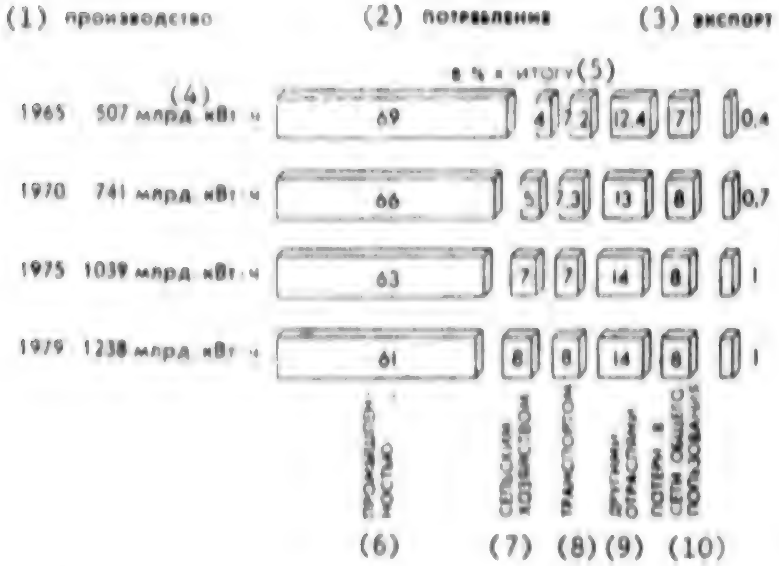


Figure 8. Electric Energy Balance of National Economy

Key:

1. Production
2. Consumption
3. Export
4. Billion kWh
5. Percentage of total
6. By industry
7. By agriculture
8. By transportation
9. By other sectors
10. Losses in general-use network

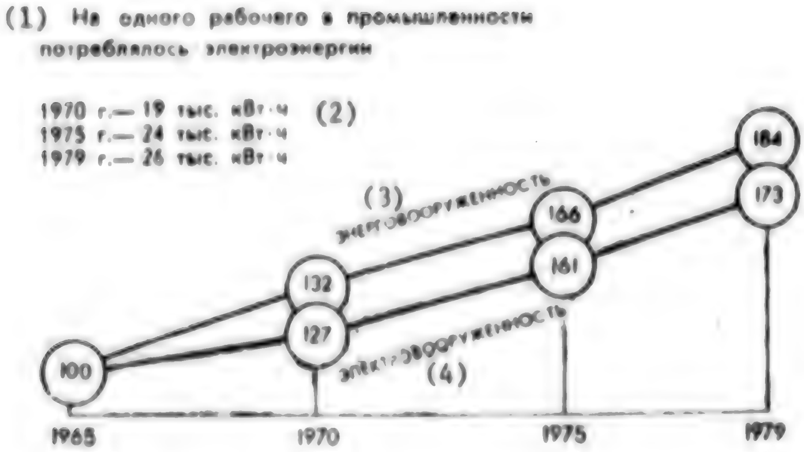


Figure 9. Power-Worker and Electric Power-Worker Ratio in Industry

Key:

1. Electric power consumed per worker in industry
2. Thousand kWh
3. Power-worker ratio
4. Electric power-worker ratio

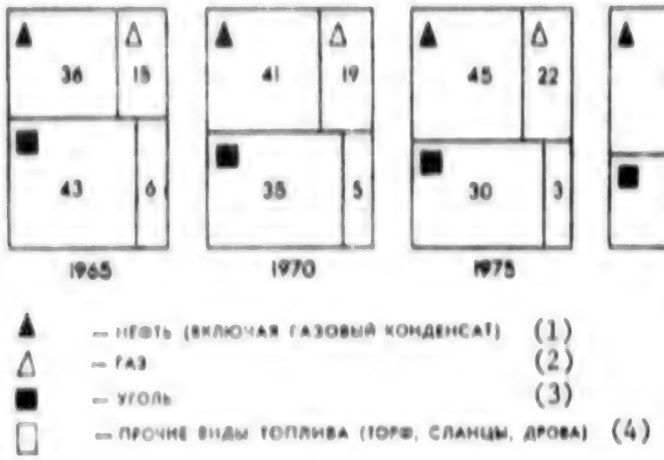


Figure 10. Structure of Fuel by Kinds, Percentage of Total

Key:

1. Oil (including gas condensate)
2. Gas
3. Coal
4. Other kinds of fuel (peat, shale, firewood)

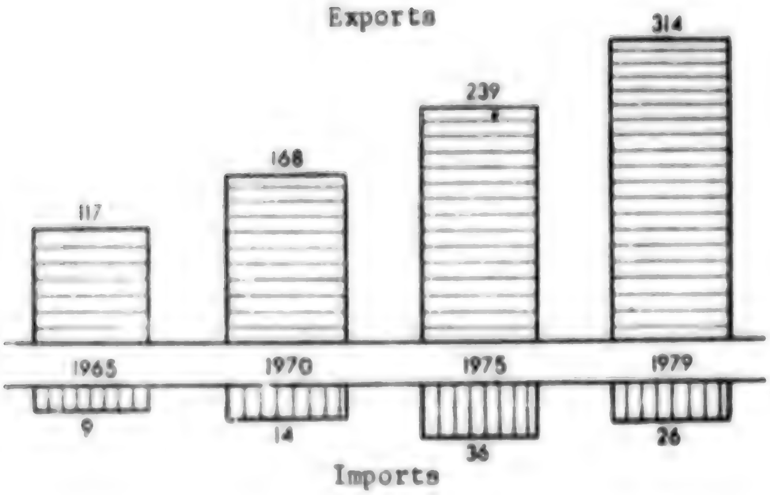
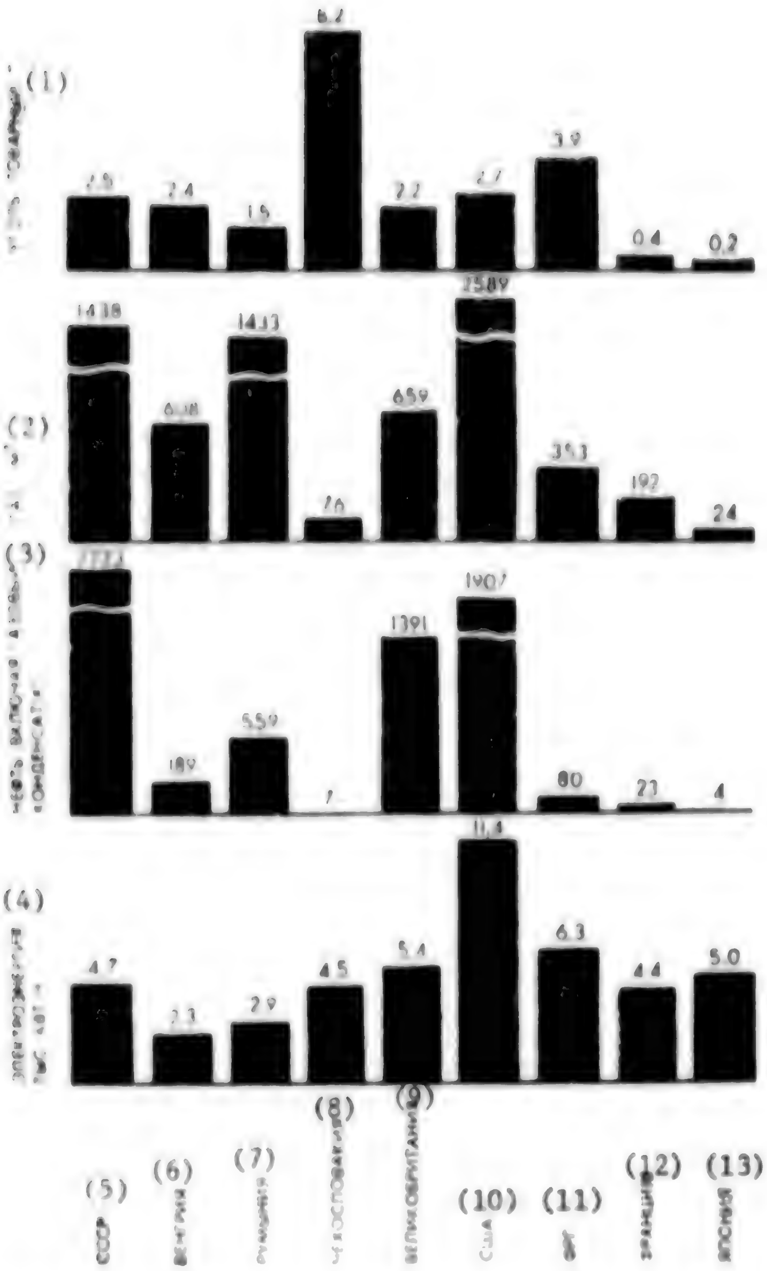


Figure 11. Exports and Imports of Fuel and Energy, Million Tons of Conventional Fuel



Key:
1. Commercial coal, tons
2. Gas, cubic meters
3. Oil (including gas condensate), kg
4. Electric power, thousand kWh
5. USSR
6. Hungary
7. Romania
8. Czechoslovakia
9. Great Britain
10. USA
11. FRG
12. France
13. Japan

Figure 12. Output of Some Kinds of Industrial Products per Member of Population in Individual Countries in 1979

COPYRIGHT: Izdatel'stvo "Nauka", "Ekonomika i organizatsiya promyshlennogo proizvodstva", 1981

8831
CSO: 1822/142

ELECTRIC POWER

SOVIET PLANS TO EXPLOIT SOLAR ENERGY REVIEWED

Paris ELECTRONIQUE ACTUALITIES in French 1 May 81 p 16

[Article by N. Miletitch of AFP]

[Text] Moscow--Solar energy, which has not really gone beyond the experimental stage in the Soviet Union, should witness some expansion in the course of the 11th five-year plan (1981-1985) as part of the exploitation of auxiliary energy resources, wind energy, and geothermal energy.

Soviet experts have long had plans to build big solar generating plants capable of supplying electric and thermal energy on an industrial scale. In order to do this, several research institutes are presently working on the development of new technology.

A pilot plant with an output of 200 to 300 megawatts should be built in the Crimea within the next few years. Thanks to an annual "sunfall" of about 2,000 hours, that plant whould produce close to 445 million kilowatt-hours per year. The plant will be linked to a traditional generating plant which will fill the gap in case of poor weather.

Composed of four 75-megawatt generating units, operating on the basis of a "generator-to-steam-turbine" thermodynamic cycle, the plant will have an independent field of heliostats and a main tower 250 meters in height. The principle the experts adopted for construction can be expanded for use in plants with capacity of up to 1,000 megawatts and more.

Soviet experts are already looking into the construction of other solar plants on this model in the republics of Central Asia, in sourthern Kazakhstan, in Daghestan (Caucasus) and in the Caucasus region.

The first experimental installation in the USSR went into operation in October 1977 at Simferopol, in the Crimea: glass panels with a total surface area of 200 square meters, covered with black paint, absorb more than 90 percent of the solar energy they receive. That installation is sufficient to heat a hotel on sunny days, or a about 220 days per year.

In Uzbekistan

Uzbekistan (Central Asia) is the ultimate experimental ground for Soviet experts, with 300 days of sun per year.

In some houses, hot water is supplied by a solar heater with panels mounted on the south-facing walls. If it gets overcast, the inhabitants are automatically connected to the "normal" power supply from the city. The installation of solar heaters involves about 15 to 20 percent more in construction costs, but makes it possible to economize up to 60 percent on fuel, according to the experts.

In the Uzbekistan desert, several geologists and shepherds have tested, with apparent success, portable solar cook-stoves composed of seven small mirrors which provide sufficient heat to reach the boiling point in one hour. Uzbek experts have also developed a solar-powered refrigerator that could supply up to 10 kg of ice per day.

Experimental water-distilling equipment has been put into use in the Uzbekistan desert: the machinery and pumps that move the water work on solar power.

Researchers from the Uzbekistan academy of sciences are presently trying to develop solar condensers. At present they have abandoned polished glass mirrors, manufacture of which is a laborious process, in favor of groups of faceted mirrors, each one of which is 5 meters in diameter.

A condenser contains 60 facets, installed on a metallic body in such a way as to be able to concentrate solar rays at a single point where the temperature reaches about 2,000 degrees.

Similar experiments are being carried out in other republics in Central Asia, in order to try to exploit the potential wealth of the sun. There remains, however, much to do in order for solar energy to begin to play an important role in the USSR's overall energy picture and become a real supplement to the traditional types of fuels.

9516
CSO: 3100/718

ELECTRIC POWER

BRIEFS

HIGH-VOLTAGE HYDRO GENERATOR--The first large high-voltage hydro generator in the world able to work without a step up transformer has been designed by scientists at the Moscow Energy Institute. It will be most useful at power stations on mountain rivers, for the faster the generator turns, the higher its coefficient is, so it can be smaller. The machine is envisaged for the Chirkey and Nurek GES's. It has been patented in a number of countries. [Moscow Domestic Service in Russian 0230 GMT 18 Mar 81]

CSO: 1822/146

FUELS

OIL PROSPECTING EQUIPMENT REQUIREMENTS OUTLINED

Moscow SOVETSKAYA ROSSIYA in Russian 8 Mar 81 p 2

[Article by G. Ukrakhovich, general director of the East Siberian production geological association for oil and gas exploration: "What to Explore With"]

> [Text] "Guarantee further technical re-equipping of the geological exploration organizations, and equip them with highly efficient equipment, apparatus and transportation vehicles."
>
> From "Main Directions for Economic and Social Development of the USSR for 1981-1985 and for the Period to 1990."

During a routine trip to a distant borehole the heavy equipment operators witnessed an oil discharge which had been unobserved until then. The "black gold" was unusually light. For the sake of experiment, one of the drivers poured the "natural gasoline" into the tank of his truck and drove down the winter road to the surprise of himself and all the others. The motor ran correctly.

This story is going around in our krays. And it does have a basis. In recent years, light oil has actually been found in East Siberia. It is distinguished by high quality characteristics. It contains few harmful admixtures and many light fractions. If diesel fuel is added to it in a definite proportion, a mixture can be obtained that is suitable for running engines. The scientists and researchers are currently engaged in problems of the more effective use of this unique oil.

The geologists, geophysicists and drillers continue to study the depths of the earth. The 26th Party Congress has set an important task for them: to guarantee accelerated development of work for geological study of the country's territory, increase the explored reserves of minerals and raw material resources, in the first place, fuel and energy, and implement measures to find oil and gas fields in East Siberia.

Our production association "Vostsibneftegazgeologiya" in the 11th Five-Year Plan is faced with creating a base for organizing the oil extracting industry. The task is very, very complicated and requires accelerated development of exploration and a considerable increase in the explored reserves. The strategy and tactics of exploration require the maximum utilization of experience with those corrections that need to be made in order to avoid repetition of past errors and miscalculations.

The sites of exploration and drilling are far from each other. Whereas in the not too distant past we concentrated work only on three main areas, now their number has risen several times. Four major expeditions based in the Bratsk, Ust'-Kut, Katangskiy and Usinskiy rayons control the base of more than 200,000 square kilometers. The exploration parties go further and further to the north, to the regions that are the most complicated for development because of their distance from the base settlements, the absolute lack of roads in the summer, and the severe winter frosts. The geologists and drillers are attracted here by one of the East Siberian storehouses of oil and gas, the Nepskiy anticline. We are exploring on a broad front here. We are trying to determine the most promising areas so that the main work of finding fields can be concentrated precisely here.

Regrettably this tactic--in our opinion the only correct one--conflicts with the plan. The fact is that today's assignment is based on the results of past years when the geologists and drillers operated on a few neighboring areas. Of course, then they worked more productively and even set records for well drilling. But the increase and expansion of the exploration spheres which requires considerable expenditures of forces, resources and time, inevitably resulted in a decrease in the indicators. After we concentrate ourselves in the promising discovered regions, this lag will undoubtedly be eliminated. But for now, the planning agencies must take into consideration the specific conditions of the exploration work and display flexibility in defining the program.

The director of the Institute of the Earth's Crust of the Siberian Department of the USSR Academy of Sciences, N. A. Logachev, recently spoke at the oblast party conference. He noted that the work at the Nepskiy anticline is being done on a high scientific and technical level. He especially stressed the need to increase the volumes of deep drilling. We are currently aimed at this goal, at finding oil and gas fields. The association has mastered the technology of deep drilling well. It has its own leading workers and has successfully drilled a well 5,000 meters deep.

Nevertheless, the production processes at the boreholes are still far from perfection. There often are standstills and cases of reduced work quality. The fault for organizing labor, the technological regime and discipline lies directly with the collectives and their leaders. We are taking the appropriate measures for this.

But we are placing great hopes on technical re-equipping. The time has come to renew the machine fleet and the rock-crushing tools. High-strength drilling pipes are extremely needed. We are also counting on interaction with the scientists. But in past years our direct ties with the main technological institutes weakened, and then stopped. The omission is obvious. We now have to make up for the loss. We have concluded contracts for cooperation with the TatNIPIneft' [Tatar Scientific Research and Planning Institute of the Oil Industry], Kuybyshev VNIPIneft' [All-Union Scientific Research and Planning Institute of the Petroleum Refining and Petrochemical Industry] and the Ufa Petroleum Institute. The content of joint research and development has been specified.

It is impossible not to mention the restricting factors that are not easy to eliminate. However, we cannot tolerate them.

It would seem that the RSFSR Ministry of Geology does not limit us in material and technical supply and allocates the necessary funds. But this is not even half, but a quarter of the problem. It is extremely important that the manufacturing plants send the equipment and materials to us no later than March in full shipments. This requirement is justified. Truck transportation connections in the regions where the geologists and drillers are working are only made on temporary winter roads in the period from December through March. Naturally,none of the equipment that comes from the suppliers after March reaches its destination. We cannot rely on the helicopters. For example, last year helicopters were successfully used to deliver only 6% of the allocated funds to the boreholes of the Lenskiy expedition after communication on the winter roads had been disrupted. They had to make do with the equipment that they managed to get.

The road workers of our association annually lay new winter roads with total length of over a thousand kilometers and they clear roughly the same amount of roads previously used. In order to drill only one well it is necessary to deliver hundreds of tons of equipment and materials to the work site. In winter, the loaded machines are sent on 300-400-kilometer trips from the base settlements of the expeditions. To haul means not to overload. But first of all, it is necessary to ship these loads from the railroad station in Lena. And here we cannot make do with winter roads alone.

Today there is an acute question of the need to build year-round roads that would link the railroad center with the base settlements of the geologists and drillers. They have already christened this future route "Lifeline." This road is also needed to develop the large deposits of potassium salts discovered in the region of the Nepskiy anticline. It can also be used by the diamond extractors of Yakutia. Of course, the RSFSR Ministry of Autmobile Roads must render the necessary help.

The problem of transportation needs the immediate resolution. The winter roads require heavy-freight all-terrain trucks of the "KrAZov" type. However, we are mainly supplied with low-tonnage trucks that are not suitable for the local conditions. It is worth thinking about the powerful special purpose trucks in a northern version. The same can be said in relation to the drilling equipment. It is time for the manufacturing plants to take into consideration the features associated with transporting it to remote regions on temporary roads and operation under conditions of severe frosts.

As for shipping our freight, the potentialities of the Nizhnyaya Tunguska River are not completely utilized. In the period of navigation it would be good to support the geologists with ships.

In a word, the success of the geologists and drillers in this kray depends a lot on the reliability of the rear support. In the Irkutskaya Oblast in 1981-1990 the Verkhne-Lenskiy territorial-production complex will be formed. As geological-economic work has shown, oil and gas may be the main base for the development of the new territorial-production complex in addition to other minerals. We have already covered the Yaraktinskiy and Markovskiy fields. Several wells drilled in the Nepskiy anticline have yielded oil. But the main work is ahead.

9135
CSO: 1822/173

DEEP-DRILLING FLOATING OIL RIG DEVELOPED FOR CASPIAN

Baku VYSHKA in Russian 1 Apr 81 p 1

[Article by A. Gol'denberg, correspondent of Azerinform: "'Kaspmorneft'" Casts Anchor"]

[Text] An unusual structure with openwork red and white derrick pointing upwards recently appeared at the 28 Aprelya field. From a distance it looks like a fantastic plant afloat, held up by tanks, winches, cranes and intersected in different directions with pipes. Only after going closer are you convinced that this is a floating borehole. "Kaspmorneft'" is written on it in large letters.

This is the name for the new semisubmersible unit for drilling exploratory wells to supplement the arsenal of the Caspian oil workers. "Kaspmorneft'" is a unit of a basically new type. In order to put it into the working position it is not necessary to fasten the platform in a fixed condition on four enormous extension supports as with its predecessors. Resting on two metal cigar-shaped pontoons, the semisubmersible unit operates afloat, "attached" to the bottom of the sea by 8 anchors weighing 17 tons each.

Special attachments to dampen the fluctuations of the waves, permit "Kaspmorneft'" to operate even under stormy conditions. This is very important on the Caspian, which is turbulent about 300 days a year.

The depth of the sea under the platform is unusual, 130 meters. "Kaspmorneft'" is faced with drilling the country's first well through such a mass of water. The maximum sea depth that is accessible to it is 200 meters. This is almost triple that of the self-elevating units currently in operation in the Caspian.

"Kaspmorneft'" considerably surpasses its predecessors in supply with automatic equipment. The course of drilling the well at the 28 Aprelya field will be controlled for the entire 4.5-kilometer distance by a system of underwater television. There is a diving complex, effective means of preventing pollution of the sea, and other modern equipment at the service of the prospectors of the depths.

The Azerinform correspondent was told by the head of the unit, engineer Afgan Khalilov who has already worked on the floating borehole "Khazar," that the set-up and tuning work will be definitively completed at the 28 Aprelya field. He said that we only have to test several systems under those conditions that the unit will have to work in. We will check the anchor winches and chains in operation, the television apparatus and other equipment. After this, "Kaspmorneft'" will start to drill its first well. It will yield important information on the oil fields on which great hopes are placed.

9035
CSO: 1822/133

MEASURES TAKEN TO PREDICT AND PREVENT GEORGIAN ENDOGENIC COAL MINE FIRES

Tbilisi ZARYA VOSTOKA in Russian 10 Apr 81 p 2

[Article by N. Kaledin, head of the department to control endogenic fires of the All-Union Scientific Research Institute of Mine Rescue, candidate of technical sciences: "By the Prediction Method"]

> [Text] The broad program of further re-equipping of the coal industry in the country that was planned by the 26th CPSU Congress advances before the Georgian miners new and important tasks to increase coal extraction. Their succesfull realization is tied a great deal to the resolution of a number of questions, including the control of endogenic fires in the mines of the Tkibuli-Shaorskiy fields.

Endogenic fires are a threatening phenomenon of nature that develop during self-heating of coal. Consequently, the complex program of controlling endogenic fires that was developed in the All-Union Scientific Research Institute of Mine Rescue is of primary importance. It includes the development of methods of prediction, and methods and means of preventing and extinguishing the fires.

For the first time in world practice, the institute has developed a method for detecting early signs of self-combustion of coal. The method is based on determining the correlation in the mine atmosphere of unlimited hydrocarbons, ethylene and acetylene. As it was found, only these gases can be used to predict an imminent catastrophe. Although the gases are present in the mine atmosphere in quite negligible quantities, in millionths of a percent, this is quite sufficient to judge the change in temperature of the coal in the mines. It became possible to detect the presence of these substances thanks to the creation of the latest electronic equipment.

The detection of self-heating coal at the early stage has enormous practical importance since it permits measures to be taken in time to prevent a fire. The new method has already received a high evaluation from the miners of Donbass and Vorkuta, Poland and Bulgaria. The economic effect from its practical use in the Donbass mines alone in 1980 was about 1.5 million rubles.

In order to find latent foci of endogenic fires, the institute has developed and indicator of heat emissions "Kvant." Using this instrument, one can detect a latent focus of an endogenic fire in the depth of the worked space to a distance of 10 meters. The "Kvant" instrument can also be used to monitor the thermal condition of the operating mechanisms, to find sites of heating of electric cable couplings, to take heat maps and to monitor the thermal condition of the mine shafts.

The institute has solved the problem of preventing fires in a basically new way. A composition based on polyvinyl acetate emulsion has been developed to prevent self-combustion of the coal. The composition is used to cover bare surfaces of coal blocks, as well as accumulations of pulverized coal. In order to isolate worked spaces of active working faces, work is being done to use carbamide foam plastic, gypsum, cement and other construction materials, as well as production wastes. The "Pena-1" units are being used more extensively at the Donbass mines. They are designed to produce and lay carbamide foam plastic. The sets of equipment "Temp," "Monolit," and "Pnevmonlit" are being used to erect structures made of gypsum. One should especially note the set of equipment KTT for guniting and packing the worked space. It mechanizes the complex process of isolation work and considerably reduces its periods. This is especially important in an emergency situation. Finely dispersed powders, foamed argillaceous pulp, air-mechanical foam, as well as inert gases that have been developed in the institute are widely used to extinguish fires.

The developments of our institute can have broad practical application in the Georgian mines. Definite steps have already been taken in this direction. At the request of the specialists of the mine rescue service of Georgia, the Donetsk scientists are equipping a special laboratory in Tkibuli to find early signs of self-combustion of coal and train personnel to work in it. The availability of this laboratory will help to detect endogenic fires at an early stage and to take timely measures to prevent and eliminate them.

The leaders of the mines and production association "Gruzugol'" have shown great interest in many of the institute's developments. They are already preparing to conclude contracts for creative cooperation between the production association "Gruzugol'" and our institute which provide for a program of further perfection of the methods and means of preventing underground fires. The institute will prepare and transfer to the association the technical documents for the KTT complex that is designed to prevent and extinguish underground fires by the method of guniting and packing. According to the planned program, the production association will make this complex with its own forces.

The Tkibuli miners of shaft "Vostochnaya-2" are faced with excavating coal in horizontal layers. Here, for the first time in the Georgian mines, complex mechanization of the production processes will be used. However, preliminary studies are convincing that on this experimental section, a situation of so-called increased endogenic fire danger could arise. Consequently, the institute has taken upon itself the commitment to formulate a set of measures to prevent endogenic fires on precisely this section. This includes the creation of a special composition designed to coat the blocks and accumulations of pulverized coal in order to prevent its self-combustion. To find latent foci of endogenic fires, the institute will give the Tkibuli miners the "Kvant" instrument and will do other work to increase the work safety of the Georgian miners.

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FUELS

COURSE OF GEORGIAN COAL INDUSTRY DEVELOPMENT DESCRIBED

Tbilisi ZARYA VOSTOKA in Russian 11 Apr 81 p 2

[Article by T. Zurabishvili, director of the Institute of Mining Mechanics of the Georgian SSR Academy of Sciences, doctor of technical sciences, professor: "Mechanisms in the Mines"]

[Text] Because of the gradual but steady decline in the reserves of rich ores, it becomes necessary to work fields with unfavorable mining and geological conditions. All of this has a considerable effect on the slowing down in rate of increase in labor productivity, and rise in capital investments. For precisely this reason, mining science is faced with a very important task of sharply increasing the technical and economic indicators for extractio. and processing of minerals in deteriorating mining and geological conditions. At the same time, it must observe the measures for protecting the depths by increasing the indicators of completeness and the quality of extracting the ore from them.

In order to solve this problem, it is necessary to expand the entire complex of engineering-technical questions associated with creating new and progressive technology, equipment for extracting and processing the minerals based on the use of highly productive mining machines and equipment. The mining scientists have done a lot in this direction. Take, for example, our institute. It is a major specialized center in the Transcaucasus. It is conducting research on all the main directions of mining science and technical progress in the mining industry, including the field of mining aerohydromechanics, working ofthe ore field beds, physics of explosion, hydro- and cable transportation, the creation of efficient technological plans of extraction and enrichment of minerals for the efficient use of the minerals in the main fields of Georgia. A considerable part of the institute's research concerns the efficient working of the Chiatura manganese field.

This is the situation here. The main product of the mining kombinat is oxide ore. The other ores, carbonate and oxidized, are still extracted in a very limited quantity. This results in the rapid depletion of the field. Preliminary calculations show that with today's intensity of extraction of oxide ores, the potential of the Chiatura mining industry will decline drastically in 15-18 years. Under these conditions, the only correct path is broad development of methods for complex working of the fields that provide for uniform extraction and processing of the rich and poor manganese ores.

Based on joint work of the specialists from the Institute of Mining Mechanics of the Georgian SSR Academy of Sciences and the mining kombinat "Chiaturmarganets," efficient methods of selective extraction of varieties of manganese ores have been developed and introduced at the Chiatura mines. A number of engineering measures have currently been taken for the maximum development of methods of complex extraction and enrichment of manganese ores on the whole for the Chiatura basin. The range of application of the highly productive longwall method is gradually increasing. The specific weight of longwall extraction is currently 60%. In the long stoping faces (longwalls), a mechanized complex is used. This is a new, most progressive stage of developing mining operations in the Chiatura basin. It is now necessary to take a clear course for broad industrial development of mechanized complexes. Their introduction into practice will promote the use of line extraction technology with the minimum losses of manganese ores.

It is impossible to increase the industrial reserves of valuable manganese ores without resolving the problem of repeated working of the Chiatura field. It is common knowledge that during its lengthy period of operation, for different reasons, fairly high-quality rich manganese ores have remained in the depths. The Institute of Mining Mechanics has developed and mastered in the Chiatura mines effective technological plans for extraction using small-sized machines and other modern equipment for these conditions.

The Georgian coal industry has now entered a new stage of development. The deep levels of the Tkibuli-Shaorskiy coal field are gradually being used. They are characterized by complicated mining and geological conditions. Dynamic phenomena previously unknown to us have appeared: mine shocks that complicate the extraction of coal and the main production processes even more. Nevertheless, the scientists have found a solution. They have established the possibility of using long stoping faces, longwalls with hydraulic flushing and the use of modern combines in the Tkibuli mines. These are only the first steps. In the near future, an efficient cyclic-line technology will be mastered here to extract coal in the longwalls with the use of combines, and further, with the use of mechanized complexes. The recommended progressive methods of working the Tkibuli-Shaorskiy field must be closely linked to the use of hydraulic flushing. This will drastically diminish the coal losses, will successfully control underground fires, and will guarantee uniform redistribution of stresses in the coal beds and side rocks that develop in the excavation sections and fields. This is especially important in preventing mine shocks.

It is understood that for all the progressive working methods suggested by the scientists to be used completely, it is necessary to set up a strong hydraulic flushing system in the Tkibuli mines. It still does not meet the requirements today. Acceleration of the rates of building the hydraulic flushing service depends not only on the production engineers, but also on the purposeful efforts of the specialists from the scientific research and planning institutes.

Georgia has barite fields, however, mechanization of the production processes in the barite mines and enrichment plants is not on the proper level. For precisely this reason, a number of scientific and technical measures have been stipulated in terms of the development of our republic's barite industry. They will be implemented by the joint efforts of the production association "Gruzgornokhim" and our institute, where, for the first time in practice, the technology has been developed to enrich poor calcite-containing barite ores and calcite tailings.

This made it possible to use the raw material comprehensively and to provide and involve in industrial use balanced reserves of calcite-containing barite ores.

Special tasks have been set for the Rachinskiy and Tsanskiy mining metallurgical kombinats. According to the long-term plan, it has been decided to put new facilities into operation here to make different arsenic preparations and super pure compounds.

A lot of work has been done by our institute at the Kvaisi lead-zinc field. An efficient technology for ore extraction was developed and introduced into production for it. The technology diminishes the loss of valuable raw material while maintaining high technical and economic indicators.

Several words about the marble industry: its development is mainly being obstructed by complicated and specific mining-geological conditions and the low level of production efficiency in extraction. Because of this, it appears that all the scientific research and experimental-industrial work associated with marble extraction should be done so that it permits complete use of the modern rock-cutting machines and units. Several steps have already been taken in this direction.

Thus, several years ago, our institute made interesting studies in the field of explosion physics. This permitted invention of the technology to extract facing material by explosion. The technology increases the product output by 60% and doubles-triples the labor productivity. However, this directivity in the development still is not used in other scientific research institutes. Too little attention is given here to the selection of efficient technological plans for extraction and treatment of such materials as granite, peat and others. Work should be intensified in this area.

At the 26th CPSU Congress and the 26th Congress of the Georgian Communist Party, attention was concentrated on further effective and efficient, comprehensive use of natural resources. The solution of these tasks is impossible without an interested attitude towards the problem by the scientists and production engineers, without the constant search for new and effective means of introducing scientific developments into production and planning of work. This approach will increase the level of theoretical and the significance of applied studies. It will help to search for new forms of integrating science with production, expand the scales of introduction and in every possible way promote the development of scientific and technical progress in the domestic mining industry.

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COAL CHEMISTRY INDUSTRY WORKS TO DEVELOP SYNTHETIC FUELS

Kiev RABOCHAYA GAZETA in Russian 14 Apr 81 p 2

[Interview with Professor S. N. Baranov, corresponding member of the UkSSR, doctor of chemical sciences: "New 'Profession' of Coal"; date and place not specified]

> [Text] "Introduce effective methods of the complex use and processing of solid and heavy liquid fuels, as well as production of synthetic fuels."
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> From "Main Directions for Economic and Social Development of the USSR for 1981-1985 and the Period to 1990."
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> Airplanes take off from the airport, cars hurry along the highway, powerful grain combines furrow the fields. Machines have conquered the world. But they need fuel. Today it is obtained from oil, however its reserves are not bottomless. An oil substitute needs to be created. The Main Directions for development of the USSR for the 11th Five-Year Plan have set the scientists the task of producing synthetic fuel. It is a question, in particular, of liquid fuel from coal.
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> This, like other coal-chemical problems, requires an academic approach, a basic study of the actual structure of coal. A new scientific institution was set up for this purpose in 1975 in Donetsk, the Institute of Physical and Organic Chemistry and Coal Chemistry of the UkSSR Academy of Sciences. In a short time it has become the center of coal chemical research in the republic.
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> We offer our readers a conversation between our correspondent and the head of one of the coal chemistry departments of the institute, Corresponding Member of the UkSSR Academy of Sciences, Doctor of chemical sciences, Professor S. N. Baranov.

[Question] First of all, Sergev Nikitovich, why has interest in coal as a source of synthetic fuel arisen with new acuteness in the world today? The problem is not a new one. Back in the 1950's in our country and abroad enterprises were working to process coal into artificial oil.

[Answer] They were soon closed because of their unprofitableness. Artificial fuel cost the state a pretty penny. The need for it seemingly declined because of the discovery of new, abundant oil fields. Then it was thought that oil would suffice for a long time. Even today our country is supplied with natural fuel and energy resources better than any other industrially developed power. The so-called energy crisis of 1973 that drastically raised the prices for oil on the world market, practically did not touch us. In the next decades, oil will remain the main source of fuel production. However, according to the predictions of many scientists, the majority of the oil wells will run dry between the 20th and 21st centuries. Today it is even more difficult to extract oil and more expensive to refine. The consumption of fuel and energy is continually rising. There is a rapid rise in the rates of producing polymer materials, artificial fibers, solvents, paints and other necessary products based on oil. In the first place, it should be reserved for chemistry. The consumption of oil as fuel should be reduced. Comrade L. I. Brezhnev spoke of this at the 26th CPSU Congress. We need to learn how to produce an inexpensive synthetic fuel from coal. Its reserves are 10-fold greater than oil.

We will not guess precisely when man will take all the oil from the depths of the earth. It is also difficult to predict the exact date of the onset of the "era of coal chemistry." One thing is clear: it is already knocking on the door. The production of synthetic fuels is one of those problems that cannot be set aside "for later," if, of course, we want the airplanes of our progeny to fly.

Reconstruction of the country's fuel and energy balance with orientation first of all on coal is inevitable. We must be ready for it socially, morally, scientifically and technically. We have a strong economic base. The USSR has the world's richest coal fields. By 1985, as predicted in the Main Directions, 770-800 million tons of coal will be hoisted. The cherished billion is not far away. Special hopes are placed on the rich field of brown coal of the Kansk-Achinsk basin. It is being worked by the open-pit method. This coal is the least expensive in the country. However, it often acts in the unattractive role of a closing fuel. It is an enticing idea that an economical liquid fuel can be obtained from this "inconvenient" coal. It is far from hopeless since the brown coal contains much more hydrogen, than, say, anthracite. It is consequently easier to convert it into a soluble state.

[Question] As it turns out, colossal, often unexpected potentialities are "encoded" in coal. A whole set of useful products can be produced from it, from ammonia to thermoplastics, strictly, everything that is currently produced from oil. Including, oil itself?

[Answer] Chemically, coal from oil is mainly distinguished only by a considerably lower content of hydrogen. The saturation of coal with hydrogen, that is, hydrogenation, or liquid hydrogenation also yields "coal oil." It would seem that in principle this is not complicated. But we have not yet succeeded in making the process economical. Liquid fuel and chemical products are now produced from coal on industrial scales only in the Republic of South Africa where coal is 6 times cheaper than oil. In our country, it is only 2-3 times cheaper. With this ratio, synthesis of fuel from coal by the known technologies is not profitable. The expenditures for isolation of pure hydrogen alone are high. Add the high pressures in the reactors, high temperatures...

[Question] Is it time to put the method of coal hydrogenation "into the archives"?

[Answer] No, why. It is possible that soon people will learn to produce pure hydrogen without special difficulty. The "raw material" for it, ordinary water, suffices on the earth. This path has not yet been followed to the end. We have to search and more boldly abandon the traditional plans. Back during World War II artificial motor fuel was produced from coal. Definite industrial experience was accumulated but is not stressed. It is not worth focusing on it alone.

Important studies are being done in the Institute of Fuel Minerals of the USSR Ministry of the Coal Industry. The Moscow scientists are not only hydrogenating coal, but together with oil. This decreases the expenditures for synthesis and produces a fairly high output of products. A continuous action unit has been operating in the institute for several years already. Construction has started of two larger units near Moscow and in the region of the Kansk-Achinsk basin.

Our institute is also working on coal hydrogenation. We are studying the effect of catalysts, different metal chlorides, on coal solubility. The catalysts are capable of accelerating the chemical reaction tens, hundreds and even thousands of times. It is important to select the most effective of them. As material for the experiment we are using brown coals from the Kansk-Achinsk basin. Good results have been obtained. For the first time without using solvents, only with the help of a successfully chosen catalyst , we succeeded in converting practically the entire organic part of the coal into a soluble state. Fuel of the gasoline type can already be produced from this liquid. What is very important is that the reaction occurs without super pressures and high temperatures. The experimental results together with our recommendations were sent to the Institute of Fuel Minerals, the country's scientific center for developing processes of coal liquid hydrogenation.

[Question] Nevertheless, with catalysts or without them, this is essentially traditional hydrogenation. Are there other, basically new methods for modifying coal in order to convert it into a soluble state?

[Answer] In my opinion, the solution to the problem of producing synthetic fuel, like the majority of other scientific problems of our time, should be sought at the junction of related sciences. Until now, only the chemists have been engaged in coal dissolving. Now, in cooperation with the Donetsk Physical-Technological Institute of the UkSSR Academy of Sciences, our department of special methods of organic and coal chemical synthesis has begun to study complex physical and chemical effects on coal. A joint scientific research problem laboratory has been set up and a special unit has been built. We are studying the "behavior" of coal, the change in its molecular structure under different extreme conditions with high pressures, treatment with ultrasound, high-frequency irradiation, etc. We are obtaining curious, at times, unexpected results. It was thus thought that pressure is not a very efficient process for breaking the intramolecular bonds of a substance. For hundreds of millions of years coal has endured the pressure of a kilometer of earth mass without any consequences. Is it worth trying at all? Under the earth the pressure is hundreds of atmospheres, while we use tens of thousands. We are trying different types of pressure: pressing, hydrostatic squeezing, hydroextrusion. It happens that the solubility of some brands of coal increases 10-16-fold.

With the help of ultrasonic irradiation, we successfully convert up to 90% of the organic part of the coal (in the pulverized state) into a soluble state in the presence of different additives in the space of an hour. In composition, this extract differs little from ordinary coal. But it is considerably less expensive and simpler to produce liquid artificial fuel of the gasoline type from it. The other valuable chemical products are easily separated at the same time.

[Question] This means success?

[Answer] We are still far from practical recommendations. The work is only beginning. It is planned for the entire 11th Five-Year Plan. Experimental data are important not only for production of synthetic fuels, but also in the future, possibly also for "peopleless" coal extraction. The UkSSR Ministry of the Coal Industry has become interested in the research. Now a republic complex target plan, program, "Energokompleks," is being formulated. In particular, it suggests extraction and transporting of coal by nontraditional methods, including, without the participation of people in the stoping faces. The Dnepropetrovsk Institute of Geotechnical Mechanics of the UkSSR Academy of Sciences that is responsible for this part of the program, has suggested business cooperation with our institute.

[Question] When they speak of the mines of the future, they generally mean complete automation of the underground operations. Machines reign in the faces while man controls them from above the earth. But in this case, something quite different is apparently being considered?

[Answer] Imagine a mine not only without people, but even without cumbersome equipment. Using ultrasonic units and chemical substances, the coal is dissolved directly in the bed. It is then pumped out on special pipes as oil is now pumped from wells. Then the expensive coal combines will become a museum rarity. Fantasy? No, because the fantastic ideas are becoming reality today.

However, let us return to the concerns of today. The 26th CPSU Congress set a specific task for the scientists, to produce synthetic fuel. Our institute is participating in resolving this problem. Already in this five-year plan the coal chemists must suggest to the manufacturers technological plans for producing inexpensive artificial fuel from coal. This, first of all, requires an deep investigation of its structure and penetration into the very essence of the enigmatic black mineral, the storer of age-old secrets of the earth.

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